



Stevens, J. M., Shiels, S., Whitehouse, M. R., Ward, A. J., Chesser, T. J., & Acharya, M. (2020). Bilateral Acetabular Fractures: Mechanism, Fracture Patterns and Associated Injuries. *Journal of Orthopaedics*, 18, 28-31. <https://doi.org/10.1016/j.jor.2019.10.012>

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[10.1016/j.jor.2019.10.012](https://doi.org/10.1016/j.jor.2019.10.012)

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Bilateral Acetabular Fractures: Mechanism, Fracture Patterns and Associated Injuries.

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Abstract:

Introduction: Acetabular fractures are uncommon and their management is often reserved for specialist pelvic and acetabular surgeons. Bilateral acetabular fractures are a particularly rare subgroup. We report the incidence, fracture pattern, mechanism of injury and outcome of patients presenting to a tertiary trauma centre with traumatic bilateral acetabular fractures.

Method: Bilateral acetabular fractures were identified from a prospective database of acetabular fractures presenting to one institution over a six-year period. Patient notes and imaging studies were reviewed to identify demographics, mechanism of injury, Injury Severity Score, fracture pattern and management. Timing of operative management was explored. Patient outcomes were collected in the form of radiographs and Oxford Hip Scores at a minimum of one-year post injury.

Results: Eight patients with bilateral acetabular fracture were identified from a database which contained records of 519 patients with acetabular fractures (incidence of 1.5% amongst patients with acetabular fractures). Motor vehicle accidents were the most common mechanism. Four acetabular fracture patterns were observed within the cohort. Radiographic union occurred in all cases and Oxford Hip Scores are suggestive of moderate to well functioning hip joints. Fractures were treated as single or staged procedures.

Conclusion: Bilateral acetabular fractures are very rare due to the unique degree and pattern of force required to fracture both acetabula. They are associated with 4 main fracture patterns and present with Injury Severity Scores that averaged 25 (severe).

They are typically observed in young males with road traffic collision being the most common mechanism of injury.

Key Words: acetabular; fracture; bilateral; trauma

Introduction:

Acetabular fractures are uncommon and their management is often reserved for specialist fellowship trained orthopaedic pelvic and acetabular surgeons. The documented incidence of acetabular fractures in the United Kingdom is 3/100 000 population/year [1]. High-energy trauma is typically required to fracture the acetabulum and can result in complex injury patterns with significant morbidity and risk of mortality. Road traffic accidents are the commonest cause, followed by falls from height <10 feet, fall from height >10 feet and pedestrians hit by a vehicle [1].

There is no literature to date which explores the mechanism, demographics or outcome of bilateral acetabular fractures. We hypothesise that a high energy force is required to simultaneously fracture both acetabula and this may result in recurring fracture patterns, associated injuries and high Injury Severity Scores.

In a study of 351 acetabular fractures, Laird and Keating report a single case of bilateral acetabular fracture, the mechanism of which is not documented [1]. Gary et al. reported on 80 acetabular fractures including one case of bilateral fracture, again the mechanism and fracture pattern is not recorded [2]. To the authors knowledge, the largest number of documented bilateral acetabular fractures in a database is fifteen [3]. While the precise mechanism of injury was not documented in this study, 14 were recorded as being due to high-energy trauma.

The aim of this study was to document the incidence of bilateral acetabular fractures and explore the mechanism of injury, fracture patterns, associated injuries, management and outcome of this rare trauma presentation.

Method and Materials:

Over a six-year period from January 2012 to July 2018, all patients with acetabular fractures who presented to a single major trauma unit and tertiary referral centre were prospectively identified and data collected on an institutional database. Details including age, gender, the mechanism of injury, the site of injury, fracture classification, Injury Severity Score (ISS) and the nature of treatment were recorded. The database was reviewed to document patients sustaining bilateral acetabular fractures. Patient medical records and digital radiographs (Kodak© Picture Archiving and Communication System) were reviewed. Acetabular fractures were classified [4] at the time of presentation based upon an analysis of the radiographs and CT scans by the specialist consultants (Figures 1, 2 and 3). Associated injuries, management and complications were recorded on a computer database for subsequent analysis.

Figure 1: Initial AP pelvis radiographs in the emergency department

Figure 2: Axial CT of left posterior wall fracture dislocation and right transverse posterior wall fracture

Figure 3: PA 3D reconstruction of fracture pattern.

Operative intervention and time between staged surgeries on each site of fracture was recorded. The approach to the fracture was identified and postoperative radiographs and CT scans were reviewed (figure 4). Oxford Hip Scores were recorded at a minimum one-year post injury[5].

Figure 4: Postoperative radiographs demonstrating bilateral internal fixation.

Results:

During the study period, a total of 527 acetabular fractures in 519 patients. Of the 527 acetabular fractures, 284 underwent operative intervention of which 245 were isolated acetabular fractures and 39 were associated with sacral or pelvic fractures. Eight bilateral acetabular fractures were recorded, which represents an incidence of 1.5% of all patients presenting with acetabular fracture.

The mechanism of injury in five cases was road traffic collision. Forklift crush injury, motorbike accident and mountain bike accident account for the remanding three cases. The patient demographic, mechanism of injury, fracture pattern, treatment and associated injuries are detailed in table 1:

Table 1: Open reduction Internal Fixation (ORIF), Kocherlagenbeck (KL), Trochanteric Flip (TF) osteotomy, Days Between Operation (DBO).

The mean age of patients sustaining bilateral acetabular fractures was 32 compared to a mean age of 39 in patients with isolated acetabular fracture requiring operation. Seven

patients were male and one was female. Six patients incurred associated injury with three patients sustaining concurrent pelvic fractures. Complex open and closed limb fractures, sciatic nerve palsy and lung injuries were also documented.

Four fractures patterns were identified; Anterior wall (n=4), posterior wall (n=4), transverse posterior wall (n=6) and anterior column posterior hemi-transverse (n=2). The mean Injury Severity Score at presentation was 25 (10-38). All patients were followed up both clinically and radiographically until union. At one year, 6 patients were able to be reviewed clinically and Oxford Hip Scores were recorded [2]. One patient had a low score indicating moderate to severe joint disease (20-29), two patients had scores that may indicate mild to moderate hip pathology (30-39), and three patients had high scores indicating satisfactory joint function (40-48). There were no superficial or deep infections and no patient required revision surgery. No neurological or vascular complications as a result of surgery were recorded although one patient did have a documented sciatic nerve palsy pre-operatively with partial resolution at one-year follow-up.

Four patients underwent sequential fixation of fractures on the same day with the remanding patients undergoing staged fixation between one and three days apart. The decision to perform staged surgery on a different day and the number of days between surgeries was dictated by operative room availability rather than patient factors.

Discussion:

Bilateral acetabular fractures are very rare and detailed documentation is currently limited to a small number of case reports [6-10]. In our series, bilateral acetabular fractures occurred in 1.5% of all acetabular fracture presentations. All patients were young, predominantly male and their injuries were associated with high-energy mechanisms with road traffic collision being the most common mechanism.

Four fractures patterns were identified; Anterior wall, posterior wall, transverse posterior wall and anterior column posterior hemi-transverse. Anterior wall fractures represent 1.8 to 3.7% of all acetabular fractures, yet appear more common in the case of bilateral acetabular fractures (n=3; 19%) [1,11,12]. Letournel et al. postulated that fractures involving the anterior acetabulum resulted from a force applied to the greater trochanter in the axis of the femoral neck. To sustain a force that can drive one femoral head posteriorly and the other anteriorly is difficult to account for. In two cases of road traffic collision this pattern was identified. Further review of patient notes revealed both patients were front seat occupants of vehicles travelling at high speed involved in head on collisions. We postulate that as the occupant enters the impact zone one femur will be driven posteriorly fracturing the acetabulum and dislocating the hip whilst simultaneously turning the patient such that the contralateral side is exposed to the same force but now at the greater trochanter driving the femur and femoral head anteriorly fracturing and dislocating the hip.

Patients who sustained bilateral acetabular fractures also had high Injury Severity Scores that correspond to the significant mechanism of injury required to generate this rare fracture pattern. Mauffrey et al. recorded Injury Severity Scores for 883 patients with acetabular fractures and reported a mean score of 12. Our patient cohort

demonstrated a significantly higher mean score with various associated injuries including associated pelvic fractures, complex and open limb fractures, lung trauma and neurological injury. These injuries were treated as both sequential and staged procedures and are generally managed on a case-by-case basis.

Bilateral acetabular fractures after epileptic seizure have previously been documented with hip dislocation being a differential diagnosis of hip pain following seizure [6-8]. Bilateral insufficiency fractures have also been reported on two occasions both of which essentially represent progression of acetabular protrusio [9,10].

To date, this is the first report in the literature which studies in detail the demographics, mechanism of injury, fracture pattern, associated injuries, management and outcome of this rare sub-group of acetabular fractures.

Conclusion: In this series, bilateral acetabular fractures represent 1.5% of all acetabular fracture presentations and are associated with four main fracture patterns. They were most often seen in younger male patients as a result of road traffic accidents. They typically present with high injury severity scores with a mean score of 25.

CONFLICT OF INTEREST and DISCLAIMER:

This study was supported by the NIHR Biomedical Research Centre at University Hospitals Bristol NHS Foundation Trust and the University of Bristol. The views expressed in this publication are those of the author(s) and not necessarily those of the NHS, the National Institute for Health Research or the Department of Health and Social Care.

There is no grant money or financial support for this research or publication.

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1 **Table 1: Open reduction Internal Fixation (ORIF), Kocherlagenbeck (KL), Trochanteric Flip (TF) osteotomy, Days Between Operation (DBO).**

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	Age	Mechanism	Fracture Pattern according to Letournel		Treatment		DBO	Associated Injuries
			Left	Right	Left	Right		
Case 1	47	Mountain Bike	Transverse posterior wall	Posterior wall	ORIF, (KL)	ORIF (KL and TF)	2	
Case 2	22	Road traffic collision	Transverse posterior wall	Transverse posterior wall	ORIF (KL)	ORIF (KL)	3	Stable thoracic vertebral fracture
Case 3	29	Fork lift crush injury	Anterior wall	Anterior Column posterior hemi-transverse	ORIF (Stoppa)	ORIF Stoppa	Same	Open pelvis injury, Superficial femoral artery tear, complex mid-foot fracture
Case 4	16	Motor bike collision	Transverse posterior wall	Anterior Column posterior hemi-transverse	ORIF (KL)	ORIF Stoppa	Same	
Case 5	38	Road traffic collision	Posterior Wall	Anterior wall	Closed reduction, stable	ORIF KL	Same	Pelvic anterior-posterior compression 2 fracture, open femur fracture
Case 6	35	Road traffic collision	Transverse posterior wall	Transverse posterior wall	ORIF (KL TF)	ORIF (KL TF)	2	Pre-op sciatic nerve palsy, pneumothorax
Case 7	22	Road traffic collision	Posterior wall	Anterior wall	Closed reduction, stable	ORIF KL	Same	
Case 8	45	Road traffic collision	Posterior wall	Posterior Wall	ORIF (KL)	ORIF (KL and TF)	1	Pipkin 4, scapula, bilateral lung contusions, Pelvic fracture lateral compression 1

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- 4 **Figure 1:** Initial AP pelvis radiographs in the emergency department



7 **Figure 2:** Axial CT of left posterior wall fracture dislocation and right transverse
8 posterior wall fracture

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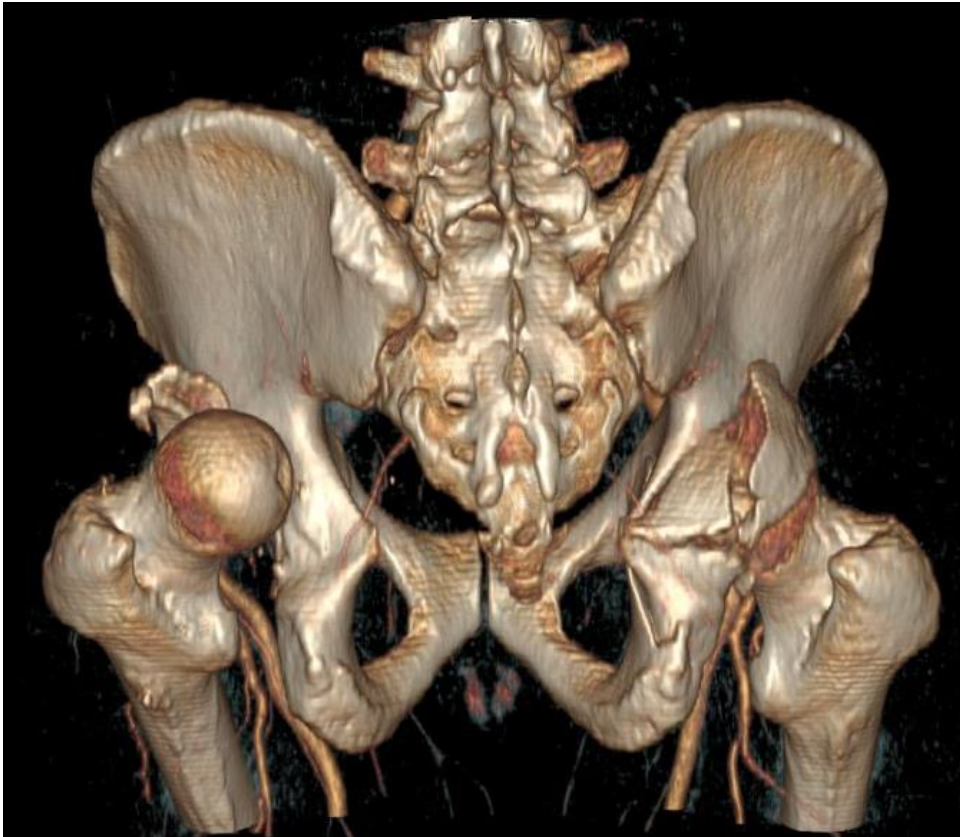


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Figure 3: PA 3D reconstruction of fracture pattern.

Operative intervention and time between staged surgeries on each site of fracture was recorded. The approach to the fracture was identified and postoperative radiographs and CT scans were reviewed (figure 4). Oxford Hip Scores were recorded at a minimum one-year post injury[5].



19 **Figure 4:** Postoperative radiographs demonstrating bilateral internal fixation.



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